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AIRCRAFT TURBINE ENGINES OF POLISH PRODUCTION,(U)
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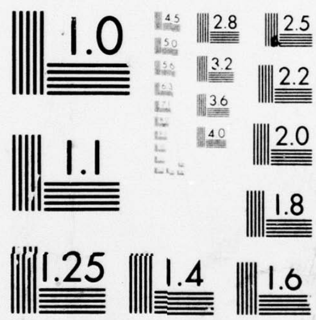

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FOREIGN TECHNOLOGY DIVISION

AIR FORCE SYSTEMS COMMAND

AIRCRAFT TURBINE ENGINES OF POLISH PRODUCTION

by

Jerzy Grzegorzewski

FOREIGN TECHNOLOGY DIVISION

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EDITED TRANSLATION

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THE AIRCRAFT TURBINE ENGINES OF POLISH PRODUCTION

(Part II)

by Jerzy Grzegorzewski, M. Eng.

The exhaust duct with a tail cone of constant cross section, is attached to a turbine body. It is a welded construction of high-temperature resistant sheet metal and consisting of two cones: internal and external, joined together with three struts. On the tailpipe, in the plane of rotation, there is an air duct nozzle for a pneumatic starting (the second variant of starting).

The tail cone is mounted to the exhaust duct by three dovetail locks (the subsequent design used the split collar mounting).

The engine lubrication system consists of the storage tank, pump, reversing valve and the ducts. The oil pump (type PZS - 1) consists of oil boost and scavenging systems and two metering micropumps. The oil and fuel lines in the initial design version were made of rubber, and the later ones, of steel.

The engine fuel system consists of the following subsystems: a fuel pump, engine speed governor, engine acceleration governor, two electromagnetic valves: starting and overflow, 12 working injectors and 6 starting injectors, mesh fuel filter lines and fittings.

The engine-mounted starting and ignition system consists of an electric starter and igniter plugs powered by a high energy system which together with other elements of a starting system is mounted on a main frame.

The engine has two independent starting systems, automatic electric system and the pneumatic system.

The Engine Development Work

Independently of changes which were introduced to the engines as a result of trials and in-flight tests, in the years 1961-1962 the version of HO - 10 engine with an afterburner was developed. This version was built and tested on a test stand. The obtained results were encouraging:

- increase of starting thrust (3 minutes) to 940 kG, ie. by about 20% without change in maximum allowed gas temperature at turbine ehaust (720°C),
- increase of specific fuel consumption during the afterburner to 1.9 kg of fuel (kg/h).

Fuel delivery to the afterburner injector was accomplished by a cone supply system. The exhaust cone was constant, not regulated. The version of HO - 10 engine with the afterburner was not further developed and did not go into production. The development work, however, permitted in a certain degree, to verify the engine gas-dynamic capabilities and the designers skills.

This short history of the conception and development work on the HO-10 engine (which was manufactured in the years 1961 - 1966) allows at least in part to get a perspective on the range and depth of work on the HO - 10 engine. This despite that in principle it was not a target engine, but fulfilled its role as a intermediate propulsion of a training plane TS - 11 "Iskra" and for several years was used in the aviation school planes.

Axial Turbine Engine GTD -350

The GTD - 350 engine produced since 1966 on a Soviet license is a dual spool helicopter engine with a two stage turbine. The compressor with seven axial stages and one centrifugal has a compression ratio of 5.9± 0.1 and airflow of 2.10 ± 0.02 kg/s at 45,000 rpm.

The exhaust duct body together with the vanes is of welded construction and made of stainless steel. The steel rotor consists of seven disc axial compressors and the centrifugal bladeless diffuser stage. The bleed valve mounted on a compressor body prevents instability of compressor action.

The axial combustion chamber of the reverse type with a central fuel injection, is supplied with air from two nozzles. The work factor changes the flow in the engine twice: in the combustion chamber and behind the low pressure turbine. The work fuel injector is the centrifugal, two channel, single nozzle type. The ignition system consists of injector and semi-conductor ignition plug. The compressor turbine of GTD - 350 engine is the single stage type. The shroudless rotor blades have "fir-tree" bases. The rotating disk is air cooled. The vanes are precision cast and rigidly mounted. The low pressure turbine (free) has two stages and rotates at constant angular velocity of 2400 rpm. The shrouded blades are fir-tree mounted. The rotating discs are joined with bolts. The vanes are welded to stationary rings. The bearings are of a ball type. The gas collector is terminated with two ducts of irregular cross section.

The engine reduction gear consists of cast magnesium alloy housing and two cylindrical gears. To the housing there are attached: electric starter of 3 kW electric power, pump, regulator, tachometer and the oil pump driven by the high compressor turbine, the speed governor and the tachometer driven by the low pressure turbine.

The closed lubrication system, with the holding tank of 12.5 l capacity and the cooler is housed on a helicopter main frame. The spur-gear oil pump with a boost section and four scavenging sections has a throughout of 7 l/m. The oil pressure is 3 ± 0.5 kg/cm^2.

The starting system assures the automatic engine restart up to the altitude of 4000 m using the electric starter. The ignitor plug is powered by a capacitive discharge system. The fuel system consists of the

pump-regulator with built-in cut off valve (the pump delivers fuel to the injector and limits the maximum power), low pressure turbine revolution limiter, the dump valve control signal transmitter and the electromagnetic valve controlling the fuel flow during starting.

The engine deicing, automatically controlled, is accomplished by compressor delivered heated air.

The maximum thrust horsepower at which five minutes of work is allowed is 400HP, the specific fuel comsumption at this condition is 0.370 kg/hph, the gas temperature behind the turbine is 970° C. Nominal thrust horsepower is 320 hp. The allowed engine working time at this power is 60 minutes. Maximum shaft rpm at the reductor output is 5904 rpm.

The acceleration time from idle to starting condition is 15 s. Outline engine dimensions: length - 1350 mm, width - 520 mm, height - 630 mm. The "dry" engine mass (without electric starter, exhaust duct, thermocouples, tachometers, oil pressure and temperature transducer) is 135 ± 2.7 kg. The present time between repairs - 1000 h.

To transmit the GTD - 350 engine power to the helicopter rotor, the three-stage main transmission WR - 2 is used. The first stage consists of two pair conical gears. The second and third stage consists of four pairs of cylindrical gears. Two unidirectional clutches permit the disconnection of transmission from the engine or engine from the transmission in the case of rotor autorotation. The transmission also drives the brake powering shaft (to brake the helicopter rotor), the tail propeller shaft, and the power generator shaft. The maximum speed of the transmission shaft or the rotor, is 246 rpm, maximum torque 2150 kg·m. The lubrication system is independent of the engine. Oil press ure is 2 to 6 kg/cm^2. Mass of the dry transmission is 290 kg, and outline dimensions are: length - [illegible]50 mm, width - 676 mm, height - 1470 mm. The transmission is in production since the middle of 1966.

Aircraft turbine engines of Polish production

1 \ 2	Lis-1	Lis-2	Lis-5	HO-10	SO-1
3	2270	2700	3380°	790	1000–2%
4	11560	11560	11560	13800	15600
5	1,07	1,07	2,0	1,15	1,045+2%
6		2400		730	888–2%
7		11200			15100
8		1,06		1,15	1,021+2%
9		2160		650	760–2%
10		10870			14500
11		1,05		1,15	1,01+2%
12	4,15:1	4,15:1	4.15:1	4,08:1	4,8:1
13		1273		wysokość – 715 szerokość – 767	wysokość – 764 szerokość 779
14		2640			2151
15	808	872	989	269	337

← height
← width

1. Parameter

2. Engine designation

3. Starting power of thrust in hp or kg

4. Starting rpm

5. Specific fuel consumption in kg/hph or kg/ kgh

6. Nominal power or thrust in kg

7. Nominal rpm

8. Nominal specific fuel consumption in Kg/ kgh

9. Nominal thrust in hp or kg

10. Speed ~~Angular velocity~~ in rpm

11. Specific fuel consumption in kg/hph or kg/ kgh

12. Compression ratio

13. Engine diameter in mm

14. Length, mm

15. Dry engine mass in kg

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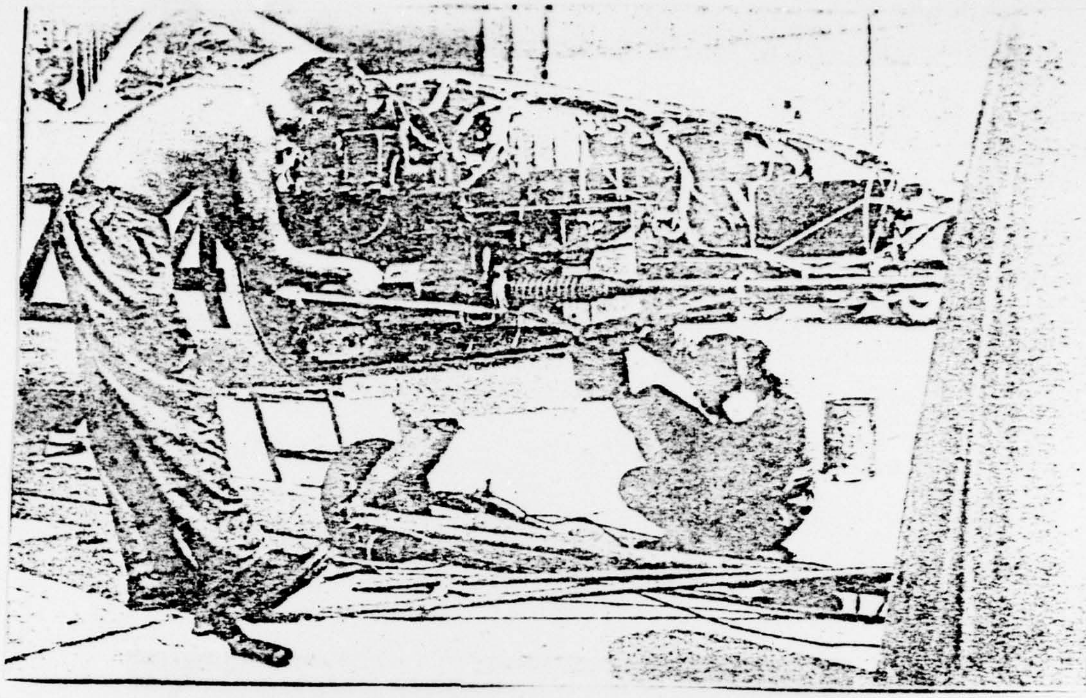
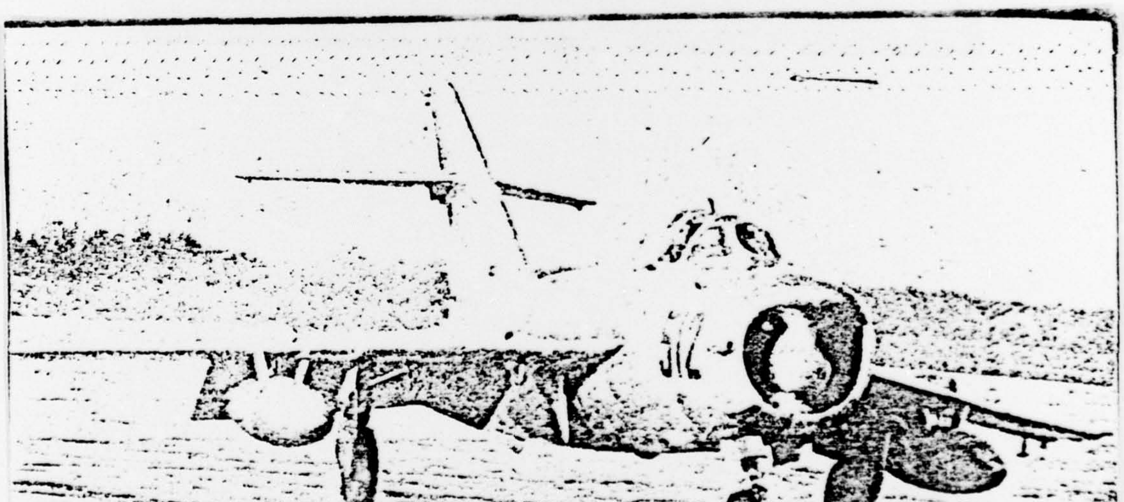


Polish training jet aircraft TS - 11 "Iskra" with the SO engine, during the scheduled maintenance.



Jet aircraft of Polish production LIM

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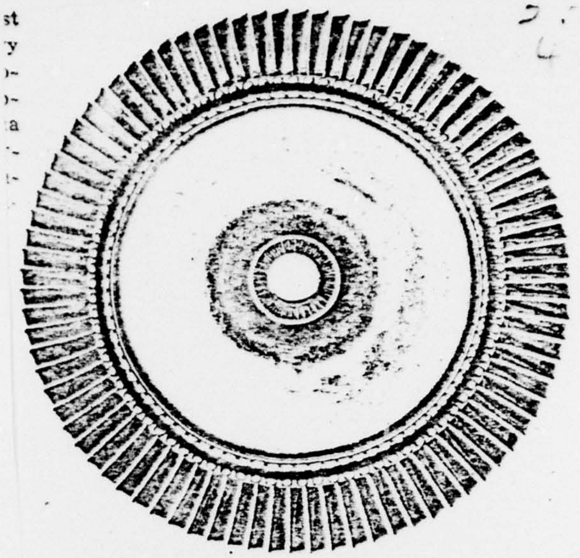
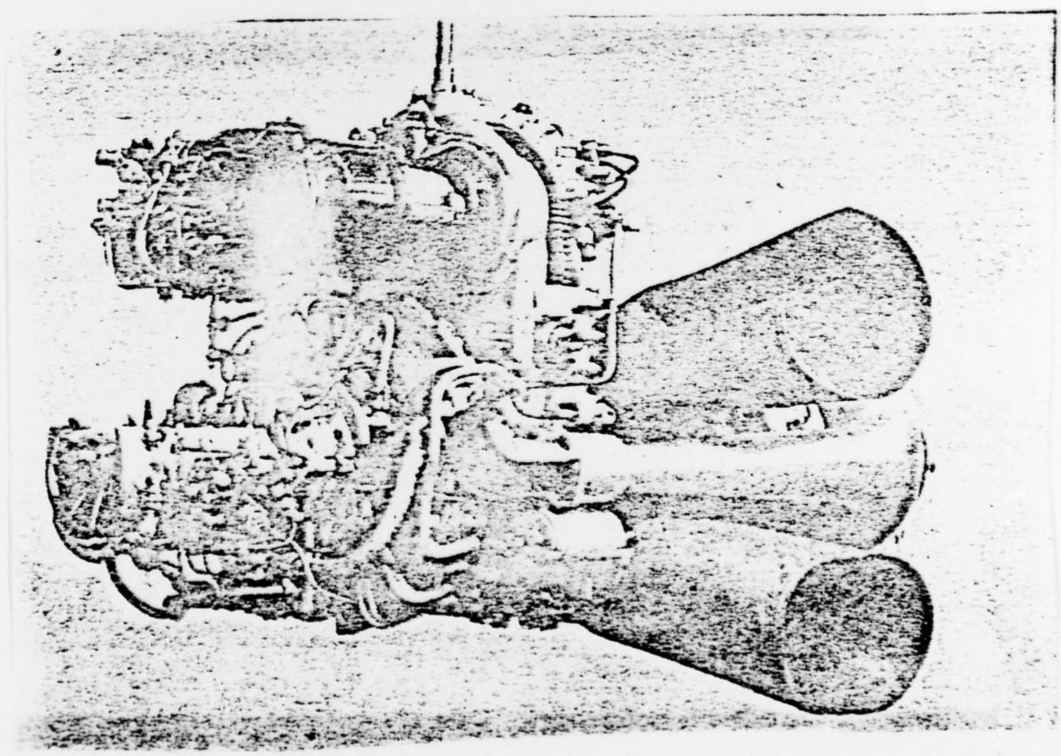


The engine turbine rotor of Polish design and production.



View of the turbine engine GTD - 350 used in Mi - 2 helicopters.

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